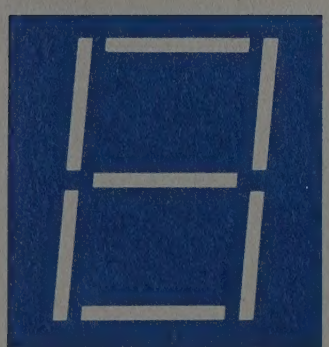
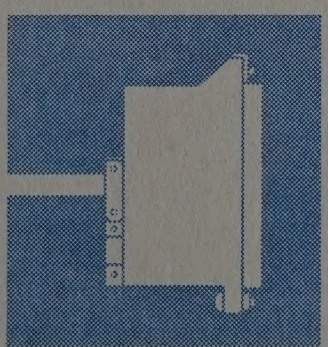
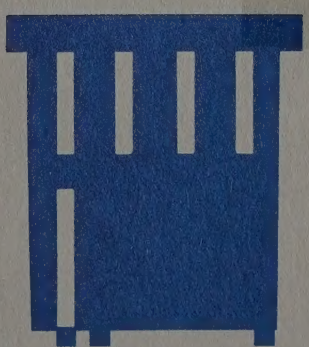
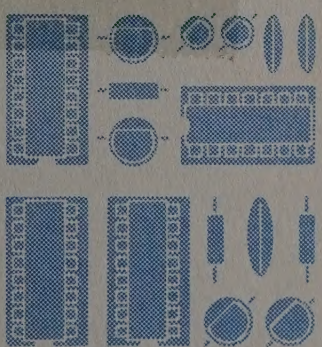
METER ROOM

model 2789
thermocouple thermometer adapter

MP MASTER
MA26225

DigiTec® Instrumentation

WARNING

This instrument is designed to prevent accidental shock to operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely prior to making any measurements. Failure to do so can result in a serious or fatal accident.

SHOCK HAZARD (As defined in Underwriters Laboratories Radio and Television Receiving Appliances Standards for Safety, Twelfth Edition, dated June 25, 1969.)

"Shock hazard shall be considered to exist at any part involving a potential of between 42.4 volts peak and 40 kilovolts peak in the following cases:

A. If the current through a load of not less than 500 ohms exceeds 300 milliamperes after 0.0003 second.

B. If the current through a load of not less than 500 ohms exceeds 5 milliamperes after 0.2 second.

C. If the time required for the current through a load of not less than 500 ohms to decrease to 5 milliamperes is between 0.1 and 0.2 second, and the total quantity of electricity passed through the load up to that time exceeds 4 millicoulombs.

D. If the time required for the current through a load of not less than 500 ohms to decrease to 5 milliamperes is between 0.03 and 0.1 second, and the total quantity of electricity passed through the load up to that time exceeds $75T\text{-}350T^2$ millicoulombs, where T is the time in seconds.

E. If the potential is more than 5 kilovolts peak and if the total capacitance of the circuit is more than 3000 micromicrofarads.

NOTE: Additional factors might apply when potentials more than 40 kilovolts peak are present.

United Systems Corporation claims proprietary rights in the material disclosed hereon. This manual is issued in confidence for engineering information only and may not be reproduced or used to manufacture anything shown without direct written permission from USC to user.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

WARRANTY

UNITED SYSTEMS CORPORATION warranties that each instrument and other articles of equipment manufactured by USC to be free from defects in material and workmanship, when subjected to normal use and service. This warranty is expressly limited to the servicing and/or adjusting of USC supplied equipment (i. e. USC is not liable for damage to customer supplied equipment interfaced with USC equipment) returned, freight prepaid, to the factory or to the nearest factory authorized service center within one year from date of delivery; and to the repairing, replacing or adjusting of parts (excepting lamps, fuses, batteries, probes and electro-mechanical assemblies) which upon examination shall be found defective. This warranty shall not apply to any instrument or other article of equipment which has been repaired or altered outside of USC factory or authorized service stations nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation of use not in accord with instructions furnished by the manufacturer.

Material on electro-mechanical assemblies is warranted for 1 year from the date of delivery while labor is warranted for 90 days from the same date.

This warranty is expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and UNITED SYSTEMS CORPORATION neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products beyond the specifically provided hereinabove.

TABLE OF CONTENTS

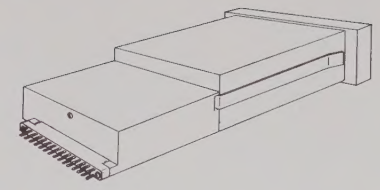
		Page
1.	GENERAL INFORMATION	1
1.1	Technical Characteristics	1
1.2	Precautions	2
2.	OPERATION	2
2.1	Power Connections	2
2.2	Thermocouple Connection	2
2.3	External Ice Point Compensation	2
2.3.1	Extending Thermocouple Leads	2
2.4	Analog Output	3
2.5	System Accuracy	3
2.6	Open Thermocouple Indication	3
2.7	System Interfacing	3
3.	INSTALLATION	3
4.	CALIBRATION	4
4.1	Linearity Check	5
5.	PARTS ORDERING	7

LIST OF ILLUSTRATIONS

Figure 1	Power Connection (±5V DC)
Figure 2	Probe & Ice Point Diode Connections
Figure 3	Dimension
Figure 4	Installation
Figure 5	Component Location, Models JC, JF
Figure 6	Schematic, Models JC, JF
Figure 7	Component Location, Models TC, TF
Figure 8	Schematic, Models TC, TF
Figure 9	Component Location, Models EC, EF
Figure 10	Schematic, Models EC, EF
Figure 11	Component Location, Models KC, KF
Figure 12	Schematic, Models KC, KF

1. GENERAL INFORMATION

The 2789 Adapters conveniently attach to a Model 2770 or 2780 to provide temperature measurements of a complete spectrum of ranges compatible with the most commonly accepted thermocouple sensors.



1.1 TECHNICAL CHARACTERISTICS

Fahrenheit

Adapter Number	2789JF	2789TF	2789EF	2789KF
Range	-292.0° to +1400°F	-240° to +752.0°F	-144.0° to +1832.0°F	-72.0° to +1999.9°F
Sensor Types	Iron Constantan	Copper Constantan	Chromel Constantan	Chromel Alumel
*Conformity @23°C ±3°C <85% r.h.	±1.3°F	±1.3°F	±1.3°F	±1.7°F
Analog Output (±3%)	6.5 mV/°F	12.3 mV/°F	5 mV/°F	4 mV/°F
	3-1/2 digit Model (mated with Model 2770)		4-1/2 digit Model (mated with Model 2780)	
Resolution & Repeatability	1°F		0.1°F	
Temperature Coefficient	±0.1°/°C		±0.09°/°C	

Celsius

Adapter Number	2789JC	2789TC	2789EC	2789KC
Range	-180° to +760°C	-152° to +400°C	-98° to +1000°C	-58° to +1372°C
Sensor Types	Iron Constantan	Copper Constantan	Chromel Constantan	Chromel Alumel
*Conformity @23°C ±3°C <85% r.h.	±0.7°C	±0.7°C	±0.7°C	±1.0°C
Analog Output (±3%)	12 mV/°C	23 mV/°C	9.3 mV/°C	7.5 mV/°C
	3-1/2 digit Model (mated with Model 2770)		4-1/2 digit Model (mated with Model 2780)	
Resolution & Repeatability	1°C		0.1°C	
Temperature Coefficient	±0.1°/°C		±0.05°/°C	

COMMON SPECIFICATIONS

Input Impedance	1 MΩ
Input Bias Current	20 nA Maximum
AC Rejection	
Normal Mode	45 dB @ 50/60 Hz
Common Mode	100 dB @ dc, 30 dB @ 50/60 Hz
Overload Protection	30V dc or 30V ac Peak
Response Time	2 seconds
Ice Point Conformity	±0.025°/°C
Dimensions	4.39"W x 1.89"H x 7.95"D (11.15cm W x 4.80cm H x 20.19cm D) (See Figure 3 for details)
Mounting Hole	3.75" x 1.72" (9.53cm x 4.37cm)

*All instruments conform to NBS 125 Table which supersedes NBS 561 Table.
FOR ADDITIONAL SPECIFICATIONS - Refer to the Model 2770 or 2780 Instruction Manual.
Specifications are subject to change without notice.

1.2 PRECAUTIONS

NOTE

The Model 2789 is an adapter for DigiTec's Models 2770 and 2780 Panel Meters. All information relating specifically to the Models 2770 and 2780 is found in the instruction manual for that instrument (88-02770 or 88-02780 respectively). It is advisable that the operator familiarize himself with that manual, as well as this one, before operating the instrument.

These units do not contain a physical fuse, but instead, incorporate protective devices on the main board of the panel meter which are designed to open if an overload condition should occur. (Refer to appropriate panel meter manual).

2. OPERATION

2.1 POWER CONNECTIONS

WARNING

These instruments are designed to be used only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury. Refer to SHOCK HAZARD on inside front cover of the Panel Meter Instruction Manual.

Input terminations must be insulated before applying an input signal. For maximum safety turn off all power to the circuit being measured before connecting or disconnecting leads.

Failure to use power line ground according to the latest electrical code may result in a SHOCK HAZARD or unstable readings. Power connections must be properly insulated before applying power.

These adapters have a rear, screw terminal barrier strip for line power and thermocouple connections. Proper line connection and required jumpers for 115VAC or 220VAC operation are indicated above the barrier strip on the rear board. To operate this instrument, earth ground as well as high and low power MUST be supplied. Unstable readings may occur if the earth ground connection is deleted. (See Figure 1)

CAUTION

DO NOT apply AC power to units mated with a panel meter containing the suffix "R" in the Model Number.

"R" Option models operate on +5VDC and power is connected as shown in Figure 1.

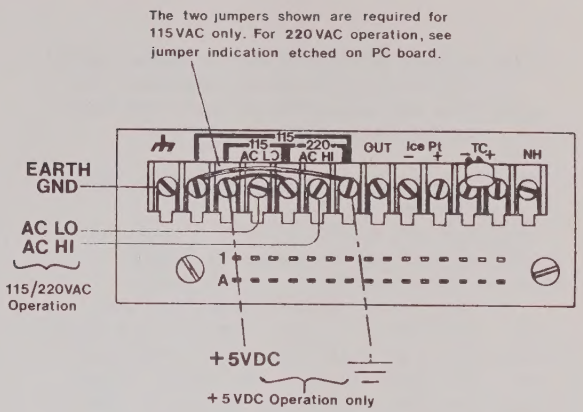


Figure 1

2.2 THERMOCOUPLE CONNECTION

Thermocouple leads are connected to screw terminals on the rear barrier strip. These terminals are marked "TC -" or "TC +". The accompanying table indicates the color code and polarity of the various thermocouples usable with 2789 Adapters.

Type	Material	Color	Polarity
J	Iron	White	+
	Constantan	Red	-
T	Copper	Blue	+
	Constantan	Red	-
E	Chromel	Brown	+
	Constantan	Red	-
K	Chromel	Yellow	+
	Alumel	Red	-

2.3 EXTERNAL ICE POINT COMPENSATION

When thermocouple wires are attached to dissimilar metals (the screw terminals), an undesired, error producing voltage is produced. These additional voltages are compensated electronically by a diode located adjacent to the thermocouple input.

NOTE

If this diode is damaged, or for any reason requires replacement, the adapter module will need to be recalibrated. (See Section 4).

2.3.1 EXTENDING THERMOCOUPLE LEADS

Many applications require that extension leads be used with thermocouple probes. In these applications, it may be desirable to use copper wires for extensions. If this is done, however, the diode must be relocated for proper compensation. The following procedure should be used: (See Figure 2).

1) Copper extension leads are attached to the thermocouple terminals and the thermocouple probe is attached at the distant location.

2) Carefully unsolder the diode and retain.

3) Attach another pair of copper extension leads to the screw terminals marked "Ice Pt -" and "Ice Pt +". The compensation diode is then soldered to the other end of these leads. The leads should be long enough to locate the diode in very close proximity to the junction of the extension leads and the thermocouple probe.

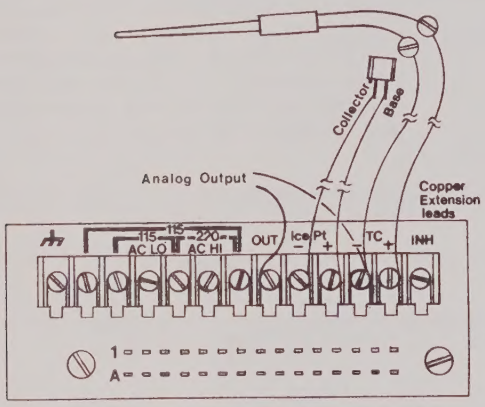


Figure 2

2.4 ANALOG OUTPUT

These adapters provide an analog output for use with peripheral devices. Output voltages for the various models are given in Section 1.1, Technical Characteristics. The analog out is located on the rear barrier strip and is labeled "OUT". Reference is to "TC-". When using this output, it is necessary to attach the thermocouple wire BEFORE attaching the analog reference wire to the "TC-" terminal.

2.5 SYSTEM ACCURACY

The system accuracy of this thermometer is the total accuracy of all factors that could produce an error. These factors include the instrument accuracy plus the probe and extension wire errors.

The total accuracy of the system may be expressed in two ways: worst case system accuracy and typical system accuracy.

The worst case system accuracy is the algebraic summation of all possible error factors. Worst case error is rarely, if ever, found in any thermometer since it is highly unlikely that all variables will have the maximum allowable error with all errors being in the same direction (i.e. all positive or all negative). A more realistic error figure can be derived by calculating the root mean square.

Error factors to include in calculations are:

1) instrument error (given in Section 1.1)

2) thermocouple error

3) extension wire error

The following equation should be used to calculate typical system accuracy: typical error =

$$\sqrt{(\text{instrument error})^2 + (\text{thermocouple probe error})^2 + (\text{extension error})^2}$$

2.6 OPEN THERMOCOUPLE INDICATION

A special "open thermocouple sense" circuit provides display indication to alert the user of defective probe condition. If a thermocouple has been damaged for any reason, the display on the 3-1/2 digit version (2770/2789) will flash. The display on the 4-1/2 digit version (2780/2789) will blank except for the most significant 1, polarity sign and decimal.

2.7 SYSTEM INTERFACING

The interfacing capability of a 2770/2789 or 2780/2789 is the same as a conventional 2770 or 2780 Panel Meter. A panel meter with an "E" or "N" suffix to the model number has positive true, TTL compatible BCD output. All pertinent information, including complete Function/Pin callout, for the analog connector (J2) can be found in the 2770 or 2780 Instruction Manual.

3. INSTALLATION

The 2789 Series Adapters attach to the rear of the panel meter and require no additional panel space (3.75" X 1.72" (9.53cm X 4.37cm).

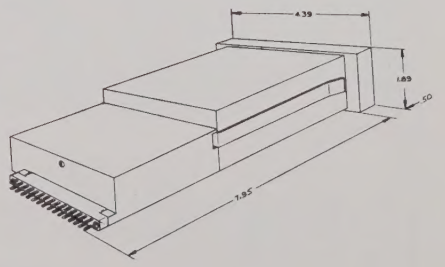


Figure 3
DIMENSION

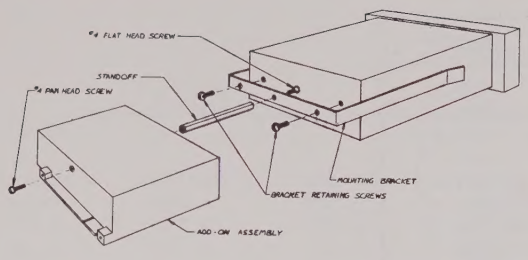


Figure 4
INSTALLATION

NOTE: If connector shell is used, add 2-1/4" to length.

To install (see Figure 4), remove the two BRACKET RETAINING SCREWS and the MOUNTING BRACKET. Discard the bracket. Using the bracket supplied with the 2789, secure the STANDOFF in the position indicated, with the FLAT HEAD SCREW. Slide the panel meter in from the front of the panel and reinstall the new MOUNTING BRACKET and RETAINING SCREWS.

After the panel meter has been mounted to the panel, carefully align the adapter, determine that a good electrical/mechanical connection has been made between the two units, and secure the adapter with the PAN HEAD SCREW through the rear of the adapter into the STANDOFF.

4. CALIBRATION

To calibrate the 2770/2789 or 2780/2789, the following procedure and Figure should be used: (Before calibration apply power and warm-up for at least thirty (30) minutes.)

1) Remove Ice Point diode from rear circuit board (retain diode). Connect a decade box (resolution of 1 ohm, range up to 4K ohms at ±0.02%, Electro Scientific Industries DB52 Dekabox or equivalent) to the Ice Point reference input on the rear terminal strip (Ice Pt - and Ice Pt +). These terminals correspond to Pins N and 12 of connector P1.

2) Short thermocouple input (the "-" and "+" terminals correspond to Pins 13 and P respectively.)

3) Connect a voltmeter from the Ice Point + terminal to ground (Pin D) and adjust decade box to obtain a voltage reading of .0000V ±.0001V. (The resistance required will be approximately 3.5K ohm).

4) Move voltmeter to Pin K of rear connector P1 and adjust R7 to obtain a voltage reading of .0000 ± .0001V.

5) Set decade box to 2.48K.

6) Adjust R10 to obtain the voltage reading indicated for the various models. Adjustments should be made to within ±.0005V.

JC 1.3324	TC 1.6733	EC .7994	KC .9487
JF 1.3324	TF 1.6733	EF .6140	KF .6594

7) Move voltmeter to Pin M of rear connector P1 and adjust R16 to obtain the voltage reading indicated for the various models. Adjustments should be made to within ±.003V:

JC 8.3679	TC 7.5789	EC 7.8555	KC 8.9641
JF 8.1683	TF 7.1943	EF 7.6702	KF 8.6748

8) Apply indicated voltage to the thermocouple input, (+) to (+) and (-) to (-). Adjust R38 for readings shown:

Hi SPAN

	INPUT	READING
JC	42.922 mV	760.4
JF	42.922 mV	1400.7
TC	20.869 mV	400.4
TF	20.869 mV	752.7
EC	76.358 mV	999.6
EF	76.358 mV	1831.3
KC	54.875 mV	1371.5
KF	44.653 mV	1989.5

9) Apply the following voltages to the thermocouple input and adjust R16 for readings indicated:

Lo SPAN

	INPUT	READING
JC	-351 µV	- 6.6
JF	-351 µV	+ 20.1
TC	-1.228 mV	- 32.6
TF	-1.228 mV	- 26.7
EC	-5.146 mV	- 97.6
EF	-5.146 mV	-143.7
KC	-2.173 mV	- 57.5
KF	-2.173 mV	- 71.6

R7 = 0°
R38 = Hi SPAN
R16 = Lo SPAN

10) Apply the following voltages to the thermocouple input and adjust R10 for the readings indicated:

	INPUT	READING
JC	-7.402 mV	-179.6
JF	-7.402 mV	-291.3
TC	-4.693 mV	-151.6
TF	-4.693 mV	-240.9
EC	48.467 mV	641.6
EF	48.467 mV	1186.9
KC	30.674 mV	736.5
KF	30.674 mV	1357.7

11) As these adjustments interact, it may be necessary to repeat Steps 8, 9 and 10 to obtain all readings.

12) CALIBRATION OF ICE POINT DIODE

A) Remove the decade box and install the ice point diode (anode to "Ice Pt. +" and cathode to "Ice Pt. -".) See Figure

B) Monitor the temperature at the ice point diode with a laboratory, glass type thermometer.

C) Adjust R10 to produce a display reading that is different from the ice point diode temperature by the amount indicated in the following table.

Example: If the ice point diode temperature on a Model JC is 24°C, R10 must be adjusted to produce a reading of 23.7 (0.3°C less than ice point temperature).

ADAPTER TYPE	ICE POINT DIODE TEMPERATURE	ICE POINT COMPENSATION
JC	from 19.0°C to 26.0°C	SUBTRACT 0.3°C
JF	from 66.0°F to 79.0°F	SUBTRACT 0.6°F
EC	from 19.0°C to 26.0°C	SUBTRACT 0.3°C
EF	from 66.0°F to 79.0°F	SUBTRACT 0.6°F
KC	from 19.0°C to 26.0°C	SUBTRACT 0.4°C
KF	from 66.0°F to 79.0°F	SUBTRACT 0.7°F
TC	from 19.0°C to 20.0°C	ADD 0.4°C
	from 20.0°C to 21.0°C	ADD 0.3°C
	from 21.0°C to 23.0°C	ADD 0.2°C
	from 23.0°C to 25.0°C	ADD 0.1°C
	from 25.0°C to 26.0°C	ADD 0.0°C
TF	from 66.0°F to 68.0°F	ADD 0.7°F
	from 68.0°F to 70.0°F	ADD 0.6°F
	from 70.0°F to 72.0°F	ADD 0.4°F
	from 72.0°F to 77.0°F	ADD 0.2°F
	from 77.0°F to 79.0°F	ADD 0.1°F

4.1 LINEARITY CHECK

The following tables provide a linearity check for all models. Apply the indicated voltage to the thermocouple input and check that the readings are within the accuracy span. The tables also provide the exact temperature for your reference.

LINEARITY CHECK

E°C

SPAN				E°F	SPAN	
Maximum	Minimum	Temp (°C)	Voltage (µV)	Temp (°F)	Maximum	Minimum
1000.6	999.4	1000.0	76358	1832.0	1833.0	1831.0
840.6	839.4	840.0	64147	1544.0	1545.0	1543.0
642.6	641.4	642.0	48467	1187.6	1188.6	1186.6
360.6	359.4	360.0	25754	680.0	681.0	679.0
232.6	231.4	232.0	15812	449.6	450.6	448.6
140.6	139.4	140.0	9078	284.0	285.0	283.0
60.6	59.4	60.0	3683	140.0	141.0	139.0
0.6	-0.6	0	0	32.0	33.0	31.0
-53.6	-52.4	-53.0	-2944	-63.4	-64.4	-62.4
-98.6	-97.4	-98.0	-5146	-144.4	-145.4	-143.4

J°C

SPAN				J°F	SPAN	
Maximum	Minimum	Temp (°C)	Voltage (µV)	Temp (°F)	Maximum	Minimum
760.6	759.4	760.0	42922	1400.0	1401.0	1399.0
652.6	651.4	652.0	36186	1205.6	1206.6	1204.6
546.6	545.4	546.0	29983	1014.8	1015.8	1013.8
329.6	328.4	329.0	12387	624.2	625.2	623.2
78.6	77.4	+78.0	4078	172.4	173.4	171.4
-7.6	-6.4	-7.0	-351	19.4	20.4	18.4
-67.6	-66.4	-67.0	-3210	-88.6	-89.6	-87.6
-113.6	-112.4	-113.0	-5155	-171.4	-172.4	-170.4
-150.6	-149.4	-150.0	-6499	-238.0	-239.0	-237.4
-180.6	-179.4	-180.0	-7402	-292.0	-293.0	-291.4

T°C

SPAN				T°F	SPAN	
Maximum	Minimum	Temp (°C)	Voltage (µV)	Temp (°F)	Maximum	Minimum
400.6	399.4	400.0	20369	752.0	753.0	751.0
300.6	299.4	300.0	14860	572.0	573.0	571.0
214.6	213.4	214.0	10036	417.2	418.2	416.2
140.6	139.4	140.0	6204	284.0	285.0	283.0
75.6	74.4	75.0	3131	167.0	168.0	166.0
19.6	18.4	19.0	749	66.2	67.2	65.2
-33.6	-32.4	-33.0	-1228	-27.4	-28.4	-26.4
-78.6	-77.4	-78.0	-2726	-108.4	-109.4	-107.4
-117.6	-116.4	-117.0	-3344	-178.6	-179.6	-177.6
-152.6	-151.4	-152.0	-4693	-241.6	-247.6	-240.6

K°C

		SPAN	
Temp (°C)	Voltage (µV)	Max	Min
1372.0	54875	1372.6	1371.4
1235.0	50096	1235.6	1234.4
1088.0	44653	1088.6	1087.4
915.0	37922	915.6	914.4
737.0	30674	737.6	736.4
311.0	12664	311.6	310.4
187.0	7617.7	187.6	186.4
122.0	5000.8	122.6	121.4
0	0	0.6	-0.6
-58.0	-2172.6	-58.6	-57.4

K°F

		SPAN	
Temp (°F)	Voltage (µV)	Max	Min
1990.4	44653	1991.4	1989.4
1679.0	37923	1680.0	1678.0
1358.6	30674	1359.6	1357.6
806.0	17664	807.0	805.0
591.8	12664	592.8	590.8
368.6	7617.7	369.6	367.0
271.6	5000.8	272.6	270.6
32.0	0	33.0	31.0
-72.4	-2172.6	-73.4	-71.4

5. PARTS ORDERING

It is recommended that replacement parts be purchased directly from United Systems Corporation or one of its authorized service centers (see inside back cover of this manual). The minimum charge is $25.00 on all orders.

For each replacement part, the following information should be included:

Instrument Model Number
Instrument Serial Number
Part Reference Designator
Part Description
Part Stock Number

2789 PARTS LIST
MAIN BOARD ASSEMBLY

Ref.	Description	Stock Number
C1,2	Capacitor, 0.01 µf @25V	56-10215A103KYR25
C3,4	Capacitor, 47 pF @1000V	56-10215A470JA10
C5	Capacitor, 0.1 µf @100V	56-12730CD104H10
D1	Diode, selected	40-16886
D2,3	Diode, dual low leakage	40-16800
D4	Diode, Reference, 1N825A	40-14859
D5,6	Diode, 1N4154	40-09297
IC1	I.C. Preamp, LM321	40-16664
IC2,3,4	I.C. Quad Op Amp, LM324	40-16665
IC5,6	I.C. Quad Switch, 4016	40-14752
R1	Resistor, 22M, 1/4W, 5%	55-10101HM022
R2	Resistor, 10K, 1/2W, 1%	55-10111ELK010
R3		
for type E	Resistor, 8.528K, 1/8W, 0.1%	55-10168BJK008R528
J	5.167K, 1/8W, 0.1%	55-10168BJK005R167
K	5.783K, 1/8W, 0.1%	55-10168BJK005R783
T	2.56K, 1/8W, 0.1%	55-10168BJK002R56
R4		
for type E	Resistor, 1.74K, 1/8W, 1.0%	55-10168ELK001R74
J	4.99K, 1/8W, 1.0%	55-10168ELK004R99
K	4.42K, 1/8W, 1.0%	55-10168ELK004R42
T	7.5K, 1/8W, 1.0%	55-10168ELK0007R5
R5,6	Resistor, 20K, 1/8W, 1.0%	55-10168ELK020
R7,16	Potentiometer, 5K	41-11611-09
R9		
for type EC	Resistor, 18.777K, 1/8W, 0.1%	55-10168BJK018R777
EF	18.991K, 1/8W, 0.1%	55-10168BJK018R991
J	18.592K, 1/8W, 0.1%	55-10168BJK018R592
KC	18.572K, 1/8W, 0.1%	55-10168BJK018R572
KF	18.916K, 1/8W, 0.1%	55-10168BJK018R916
T	18.809K, 1/8W, 0.1%	55-10168BJK018R809

R10		Potentiometer, 2K	41-11611-08
R11		Resistor, 20K, 1/8W, 1.0%	55-10168EJK020
R12			
for type	EC	Resistor, 105K, 1/8W, 1.0%	55-10168EJK105
	EF	115K, 1/8W, 1.0%	55-10168EJK115
	J	100K, 1/8W, 1.0%	55-10168EJK100
	KC	100K, 1/8W, 1.0%	55-10168EJK100
	KF	110K, 1/8W, 1.0%	55-10168EJK110
	T	107K, 1/8W, 1.0%	55-10168EJK107
R12A		Resistor, 2.21K, 1/8W, 1.0%	55-10168ELK002R21
R12B		Resistor, 2K, 1/8W, 1.0%	55-10168ELK002
*R13			
for type	E	Resistor, 259.9K, 1/8W, 0.1%	55-10168BJK259R9
	J	187.1K, 1/8W, 0.1%	55-10168BJK187R1
	K	267.6K, 1/8W, 0.1%	55-10168BJK267R6
	T	119.8K, 1/8W, 0.1%	55-10168BJK119R8
R14		Resistor, 900K, 1/4W, 0.5%	55-10164DJK900
R15,19		Resistor, 5.6K, 1/4W, 5%	55-10101HK005R6
R17		Resistor, 49.9K, 1/8W, 1.0%	55-10168EJK049R9
R18			
for type	EC	Resistor, 66.5K, 1/8W, 1.0%	55-10168EJK066R5
	EF	64.9K, 1/8W, 1.0%	55-10168EJK064R9
	JC	69.8K, 1/8W, 1.0%	55-10168EJK069R8
	JF	69.8K, 1/8W, 1.0%	55-10168EJK069R8
	KC	75K, 1/8W, 1.0%	55-10168EJK075
	KF	73.2K, 1/8W, 1.0%	55-10168EJK073R2
	TC	49.9K, 1/8W, 1.0%	55-10168EJK049R9
	TF	61.9K, 1/8W, 1.0%	55-10168EJK061R9
R18A			
for type	EC	Resistor, 1M, 1/4W, 5%	55-10101HM001
	EF	910K, 1/4W, 5%	55-10101HK910
	JC	1.5M, 1/4W, 5%	55-10101HM001R5
	JF	1.1M, 1/4W, 5%	55-10101HM001R1
	KC	1.3M, 1/4W, 5%	55-10101HM001R3
	KF	1.2M, 1/4W, 5%	55-10101HM001R2
	TC	910K, 1/4W, 5%	55-10101HK910
	TF	820K, 1/4W, 5%	55-10101HK820
R18B			
for type	EC	Resistor, 470K, 1/4W, 5%	55-10101HK470
	EF	430K, 1/4W, 5%	55-10101HK430
	JC	680K, 1/4W, 5%	55-10101HK680
	JF	510K, 1/4W, 5%	55-10101HK510
	KC	620K, 1/4W, 5%	55-10101HK620
	KF	560K, 1/4W, 5%	55-10101HK560
	TC	510K, 1/4W, 5%	55-10101HK510
	TF	430K, 1/4W, 5%	55-10101HK430
R20			
for type	E	Resistor, 1.568K, 1/8W, 0.1%	55-10168BJK001R568
	J	1.24K, 1/8W, 0.1%	55-10168BJK001R24
	KC	874.5 ohm, 1/8W, 0.1%	55-10168BJA874R5
	KF	10 ohm, 1/8W, 0.1%	55-10168BJA010
	T	1.929K, 1/8W, 0.1%	55-10168BJK001R929

R21			
for type	E	Resistor, 2.271K, 1/8W, 0.1%	55-10168BJK002R271
	J	2.407K, 1/8W, 0.1%	55-10168BJK002R407
	KC	1.076K, 1/8W, 0.1%	55-10168BJK001R076
	KF	1.94K, 1/8W, 0.1%	55-10168BJK001R94
	T	1.53K, 1/8W, 0.1%	55-10168BJK001R53
R22			
for Type	EC	Resistor, 993.3 ohm, 1/8W, 0.1%	55-10168BJA993R3
	EF	992.2 ohm, 1/8W, 0.1%	55-10168BJA992R2
	J	2.77K, 1/8W, 0.1%	55-10168BJK002R77
	KC	1.157K, 1/8W, 0.1%	55-10168BJK001R157
	KF	1.158K, 1/8W, 0.1%	55-10168BJK001R158
	T	1.225K, 1/8W, 0.1%	55-10168BJK001R225
R23			
for type	EC	Resistor, 672.3 ohm, 1/8W, 0.1%	55-10168BJA672R3
	EF	671.1 ohm, 1/8W, 0.1%	55-10168BJA671R1
	J	885.6 ohm, 1/8W, 0.1%	55-10168BJA885R6
	KC	2.882K, 1/8W, 0.1%	55-10168BJK002R882
	KF	2.880K, 1/8W, 0.1%	55-10168BJK002R880
	T	949.1 ohm, 1/8W, 0.1%	55-10168BJA949R1
R24			
for type	EC	Resistor, 538.7 ohm, 1/8W, 0.1%	55-10168BJA538R7
	EF	538 ohm, 1/8W, 0.1%	55-10168BJA538
	J	571.7 ohm, 1/8W, 0.1%	55-10168BJA571R7
	KC	806.3 ohm, 1/8W, 0.1%	55-10168BJA806R3
	KF	805.1 ohm, 1/8W, 0.1%	55-10168BJA805R1
	T	789.4 ohm, 1/8W, 0.1%	55-10168BJA789R4
R25			
for type	EC	Resistor, 368.1 ohm, 1/8W, 0.1%	55-10168BJA368R1
	EF	368.4 ohm, 1/8W, 0.1%	55-10168BJA368R4
	J	389.9 ohm, 1/8W, 0.1%	55-10168BJA389R9
	KC	416.7 ohm, 1/8W, 0.1%	55-10168BJA416R7
	KF	418.4 ohm, 1/8W, 0.1%	55-10168BJA418R4
	T	600.9 ohm, 1/8W, 0.1%	55-10168BJA600R9
R26			
for type	EC	Resistor, 294.8 ohm, 1/8W, 0.1%	55-10168BJA294R8
	EF	296.1 ohm, 1/8W, 0.1%	55-10168BJA296R1
	J	270.4 ohm, 1/8W, 0.1%	55-10168BJA270R4
	KC	800.3 ohm, 1/8W, 0.1%	55-10168BJA800R3
	KF	800.6 ohm, 1/8W, 0.1%	55-10168BJA800R6
	T	452 ohm, 1/8W, 0.1%	55-10168BJA452
R27			
for type	EC	Resistor, 1.423M, 1/4W, 0.5%	55-10164DLM001R423
	EF	589.4K, 1/4W, 0.5%	55-10164DLK589R4
	JC	949.6K, 1/4W, 0.5%	55-10164DLK946R6
	JF	600.8K, 1/4W, 0.5%	55-10164DLK600R8
	KC	399.9K, 1/4W, 0.5%	55-10164DLK399R9
	KF	----	
	TC	999K, 1/4W, 0.5%	55-10164DLK999
	TF	605.9K, 1/4W, 0.5%	55-10164DLK605R9

R28			
for type	EC	Resistor, 2.752M, 1/4W, 0.5%	55-10164DLM002R752
	EF	1.14M, 1/4W, 0.5%	55-10164DLM001R14
	JC	1.088M, 1/4W, 0.5%	55-10164DLM001R088
	JF	692.6K, 1/4W, 0.5%	55-10164DLK692R6
	KC	507.8K, 1/4W, 0.5%	55-10164DLK507R8
	KF	----	
	TC	794K, 1/4W, 0.5%	55-10164DLK794
	TF	481.7K, 1/4W, 0.5%	55-10164DLK481R7
R29			
for type	EC	Resistor, 1.372M, 1/4W, 0.5%	55-10164DLM001R372
	EF	567.2K, 1/4W, 0.5%	55-10164DLK567R2
	JC	8.2M, 1/4W, 0.5%	55-10101HM008R2
	JF	5.1M, 1/4W, 0.5%	55-10101HM005R1
	KC	576.1K, 1/4W, 0.5%	55-10164DJK576R1
	KF	588.8K, 1/4W, 0.5%	55-10164DJK588R8
	TC	644K, 1/4W, 0.5%	55-10164DLK644
	TF	386.5K, 1/8W, 0.1%	55-10168BJK386R5
R30			
for type	EC	Resistor, 856.3K, 1/4W, 0.5%	55-10164DJK856R3
	EF	353K, 1/8W, 0.5%	55-10168BJK353
	JC	931K, 1/4W, 0.5%	55-10164DLK931
	JF	588.6K, 1/4W, 0.5%	55-10164DLK588R6
	KC	690.4K, 1/4W, 0.5%	55-10164DJK690R4
	KF	701.7K, 1/4W, 0.5%	55-10164DJK701R7
	TC	496.3K, 1/8W, 0.1%	55-10168BJK496R3
	TF	300.3K, 1/8W, 0.1%	55-10168BJK300R3
R31			
for type	EC	Resistor, 578.2K, 1/4W, 0.5%	55-10164DJK578R2
	EF	237.8K, 1/8W, 0.1%	55-10168BJK237R8
	JC	553.5K, 1/4W, 0.5%	55-10164DLK553R5
	JF	348.9K, 1/8W, 0.1%	55-10168BJK348R9
	KC	617.8K, 1/4W, 0.5%	55-10164DJK617R8
	KF	627.9K, 1/4W, 0.5%	55-10164DJK627R9
	TC	418.1K, 1/8W, 0.1%	55-10168BJK418R1
	TF	251.4K, 1/8W, 0.1%	55-10168BJK251R4
R32			
for type	EC	Resistor, 460.5K, 1/8W, 0.1%	55-10168BJK460R5
	EF	189.2K, 1/8W, 0.1%	55-10168BJK189R2
	JC	373.1K, 1/8W, 0.1%	55-10168BJK373R1
	JF	235.3K, 1/8W, 0.1%	55-10168BJK235R3
	KC	9.1M, 1/4W, 5%	55-10101HM009R1
	KF	9.1M, 1/4W, 5%	55-10101HM009R1
	TC	312.1K, 1/8W, 0.1%	55-10168BJK312R1
	TF	187.5K, 1/8W, 0.1%	55-10168BJK187R5
R33			
for type	EC	Resistor, 392.3K, 1/8W, 0.1%	55-10168BJK392R3
	EF	161.4K, 1/8W, 0.1%	55-10168BJK161R4
	JC	257.7K, 1/8W, 0.1%	55-10168BJK257R7
	JF	161.8K, 1/8W, 0.1%	55-10168BJK161R8
	KC	1.91M, 1/4W, 1.0%	55-10164EJM001R91
	KF	1.96M, 1/4W, 1.0%	55-10164EJM001R96
	TC	240.8K, 1/8W, 0.1%	55-10168BJK240R8
	TF	145K, 1/8W, 0.1%	55-10168BJK145

R34			
for type	EC	Resistor, 276.6K, 1/8W, 0.1%	55-10168BJK276R6
	EF	114.2K, 1/8W, 0.1%	55-10168BJK114R2
	JC	174.2K, 1/8W, 0.1%	55-10168BJK174R2
	JF	109.9K, 1/8W, 0.1%	55-10168BJK109R9
	KC	298.9K, 1/8W, 0.1%	55-10168BJK298R9
	KF	304.1K, 1/8W, 0.1%	55-10168BJK304R1
	TC	184.6K, 1/8W, 0.1%	55-10168BJK184R6
	TF	111.2K, 1/8W, 0.1%	55-10168BJK111R2
R35			
for type	EC	Resistor, 57.94K, 1/8W, 0.1%	55-10168BJK057R94
	EF	22.941K, 1/8W, 0.1%	55-10168BJK022R941
	JC	66.53K, 1/8W, 0.1%	55-10168BJK066R53
	JF	41.09K, 1/8W, 0.1%	55-10168BJK041R09
	KC	31.519K, 1/8W, 0.1%	55-10168BJK031R519
	KF	30.631K, 1/8W, 0.1%	55-10168BJK030R631
	TC	76.73K, 1/8W, 0.1%	55-10168BJK076R73
	TF	44.17K, 1/8W, 0.1%	55-10168BJK044R17
R36		Resistor, 100 ohm, 1/4W, 5%	55-10101HA100
R37			
for type	EC	Resistor, 43.2K, 1/8W, 1.0%	55-10168EJK043R2
	EF	20.5K, 1/8W, 1.0%	55-10168EJK020R5
	JC	57.6K, 1/8W, 1.0%	55-10168EJK057R6
	JF	28.7K, 1/8W, 1.0%	55-10168EJK028R7
	KC	34K, 1/8W, 1.0%	55-10168EJK034
	KF	15.4K, 1/8W, 1.0%	55-10168EJK015R4
	TC	115K, 1/8W, 1.0%	55-10168EJK115
	TF	59K, 1/8W, 1.0%	55-10168EJK059
R38		Potentiometer, 500 ohm	41-11611-06
R39		Resistor, 4.99K, 1/8W, 1.0%	55-10168EJK004R99
R40			
for type	EC	Resistor, 1M, 1/4W, 0.5%	55-10164DJM001
	EF	2M, 1/4W, 0.5%	55-10164DLM002
	JC	1M, 1/4W, 0.5%	55-10164DLM001
	JF	1M, 1/4W, 0.5%	55-10164DLM001
	KC	301K, 1/8W, 0.1%	55-10168BJK301
	KF	576K, 1/4W, 0.5%	55-10164DJK576
	TC	1M, 1/4W, 0.5%	55-10164DJM001
	TF	2M, 1/4W, 0.5%	55-10164DJM002
R41			
for type	EC	Resistor, 434.9 ohm, 1/8W, 0.1%	55-10168BJA434R9
	EF	267.9 ohm, 1/8W, 0.1%	55-10168BJA267R9
	JC	182.6 ohm, 1/8W, 0.1%	55-10168BJA182R6
	JF	182.6 ohm, 1/8W, 0.1%	55-10168BJA182R6
	KC	950.9 ohm, 1/8W, 0.1%	55-10168BJA950R9
	KF	660.9 ohm, 1/8W, 0.1%	55-10168BJA660R9
	TC	345.2 ohm, 1/8W, 0.1%	55-10168BJA345R2
	TF	348.4 ohm, 1/8W, 0.1%	55-10168BJA348R4
R42			
for type	EC	Resistor, 0 ohm, circuit jumper	50-07657
	EF	0 ohm, circuit jumper	50-07657
	JC	580 ohm, 1/8W, 0.1%	55-10168BJA580
	JF	358.2 ohm, 1/8W, 0.1%	55-10168BJA358R2
	KC	0 ohm, circuit jumper	50-07657

KF	Resistor, 0 ohm, circuit jumper	50-07657
TC	600.1 ohm, 1/8W, 0.1%	55-10168BJA600R1
TF	172.1 ohm, 1/8W, 0.1%	55-10168BJA172R1
R50-65 for types EC, EF, JC, JF, KF, TC & TF	Resistor, 100 ohm, 1/4W, 5%	55-10101HA100
R54-65 for type KC	Resistor, 100 ohm, 1/4W, 5%	55-10101HA100
Complete Board Assembly 2789 type	EC	05-16697-07
	EF	05-16697-08
	JC	05-16697-03
	JF	05-16697-04
	KC	05-16697-05
	KF	05-16697-06
	TC	05-16997-01
	TF	05-16997-02

* If the serial number of the instrument is less than 61560650, R13A will also be included on the board (in series with R13). Values for the various models are as follows:

for type E&K	Resistor, 49.9K, 1/8W, 1.0%	55-10168EJK049R9
J	Resistor, 35.25K, 1/8W, 0.1%	55-10168BGK035R25
T	Resistor, 22.941K, 1/8W, 0.1%	55-10168BJK022R941

D1, selected ice-point diode is matched with R13/R13A. If either resistor or diode must be replaced, components must be matched.

REAR BOARD & CONNECTOR ASSEMBLY

Description	Stock Number
P.C. Board	54-16881
Connector (to instrument)	51-07546-15
Connector Key	51-11797
Terminal Block	50-12738-13
Ice Point Diode, D1	40-16886

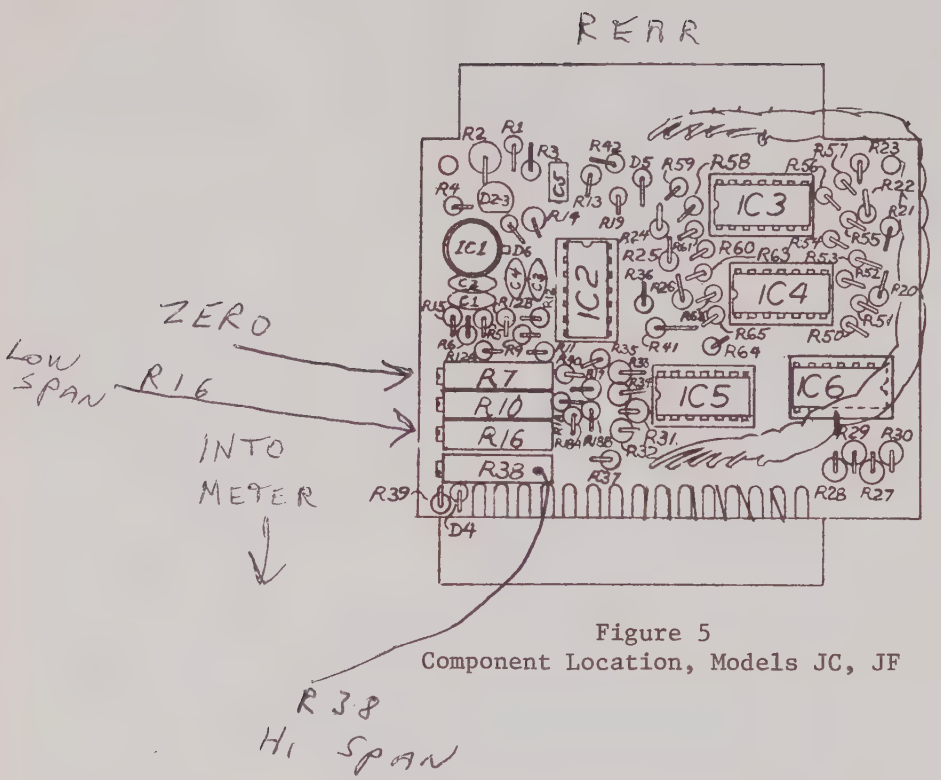


Figure 5
Component Location, Models JC, JF

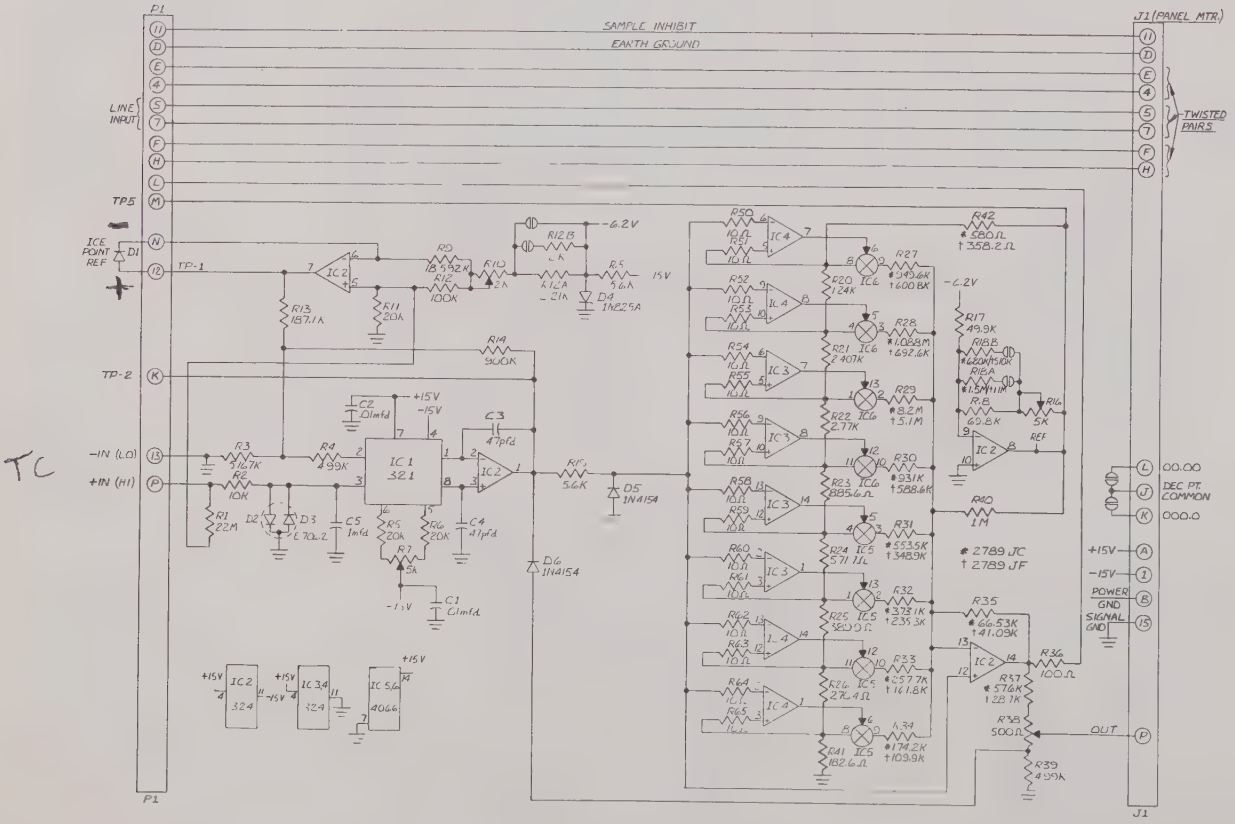


Figure 6
Schematic, Models JC, JF

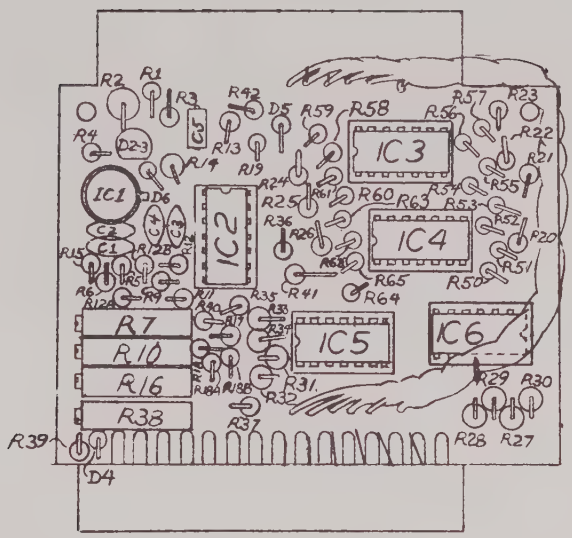


Figure 7
Component Location, Models TC, TF

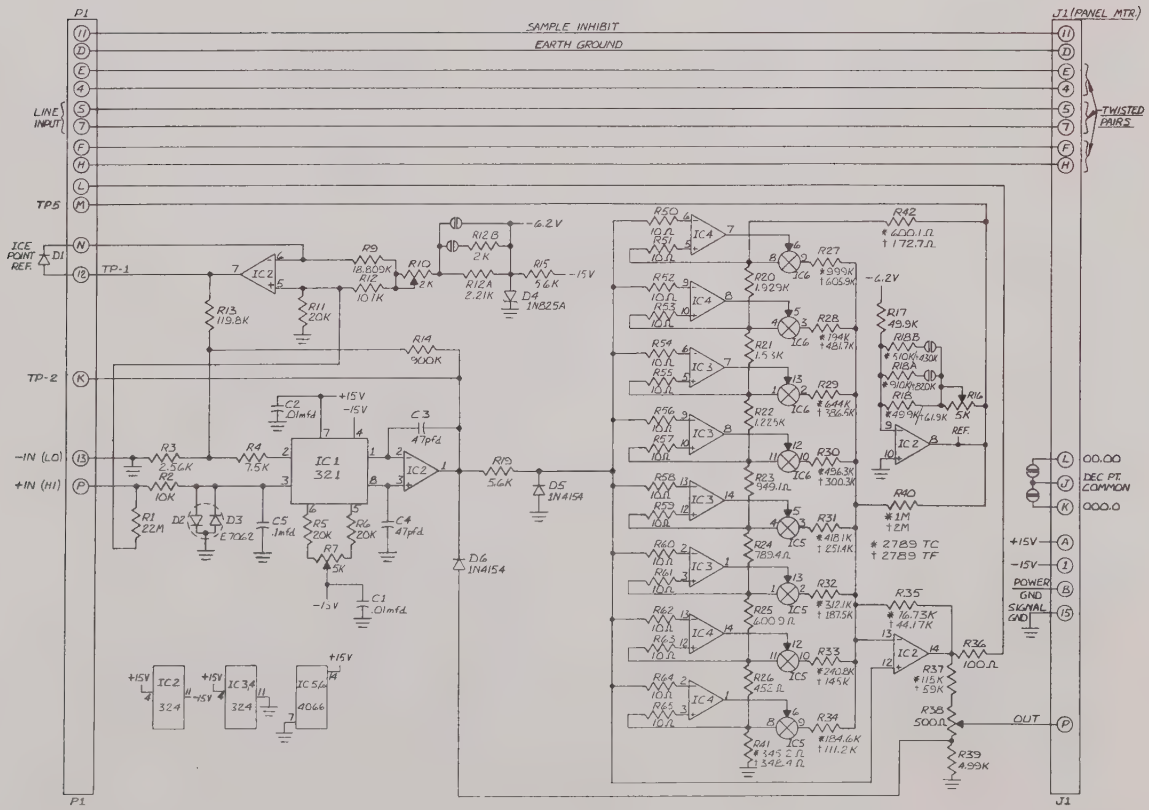


Figure 8
Schematic, Models TC, TF

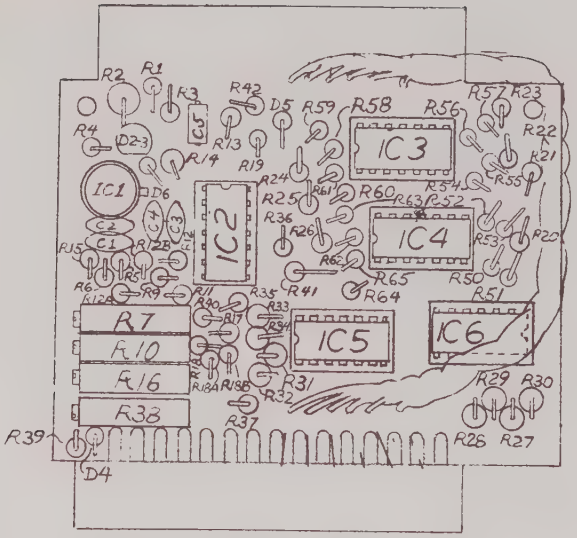


Figure 9
Component Location, Models EC, EF

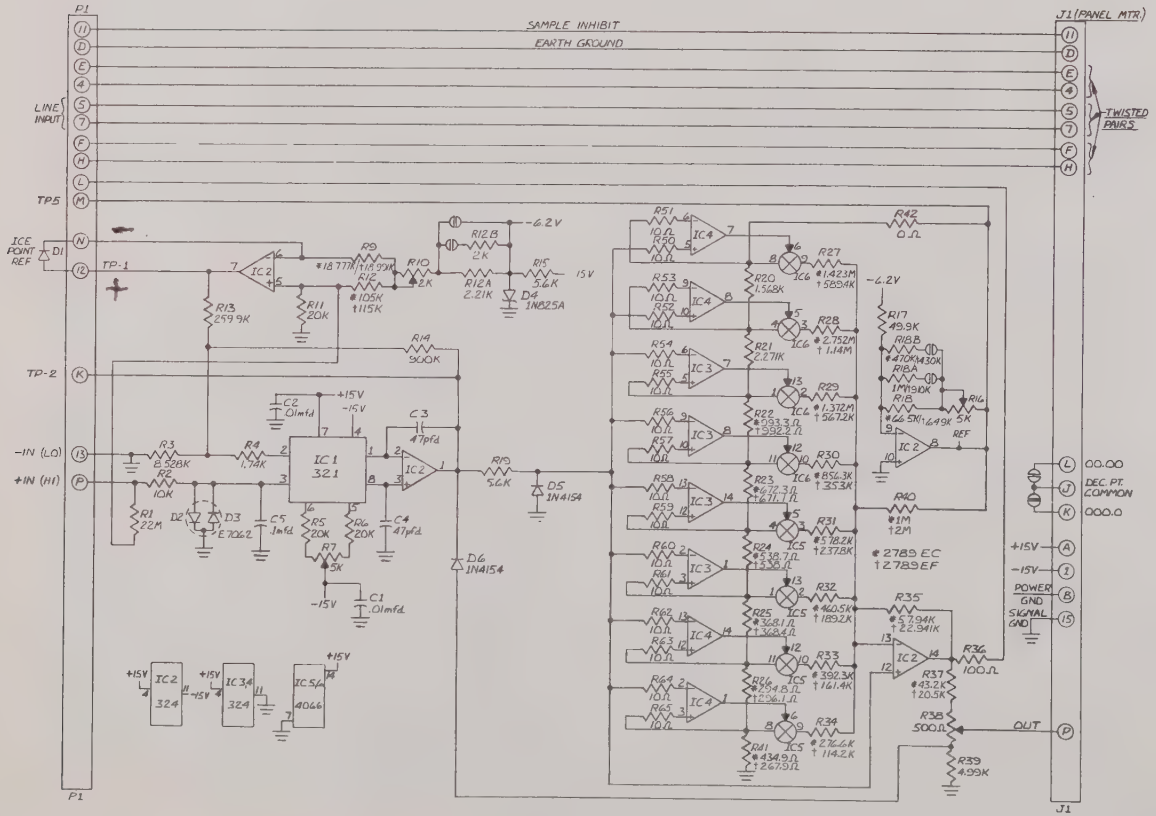


Figure 10
Schematic, Models EC, EF

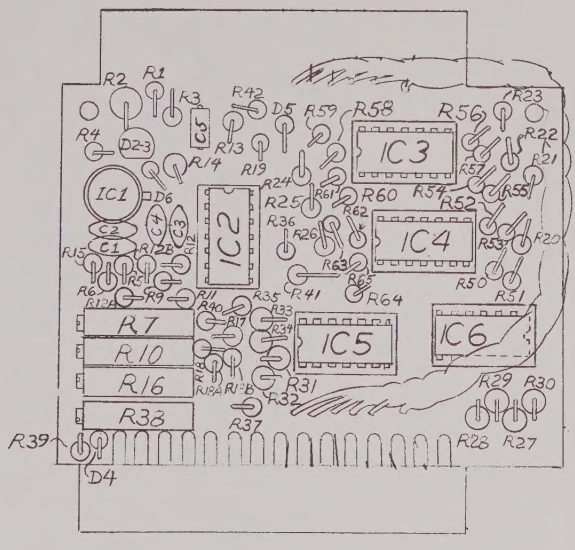


Figure 11
Component Location, Models KC, KF

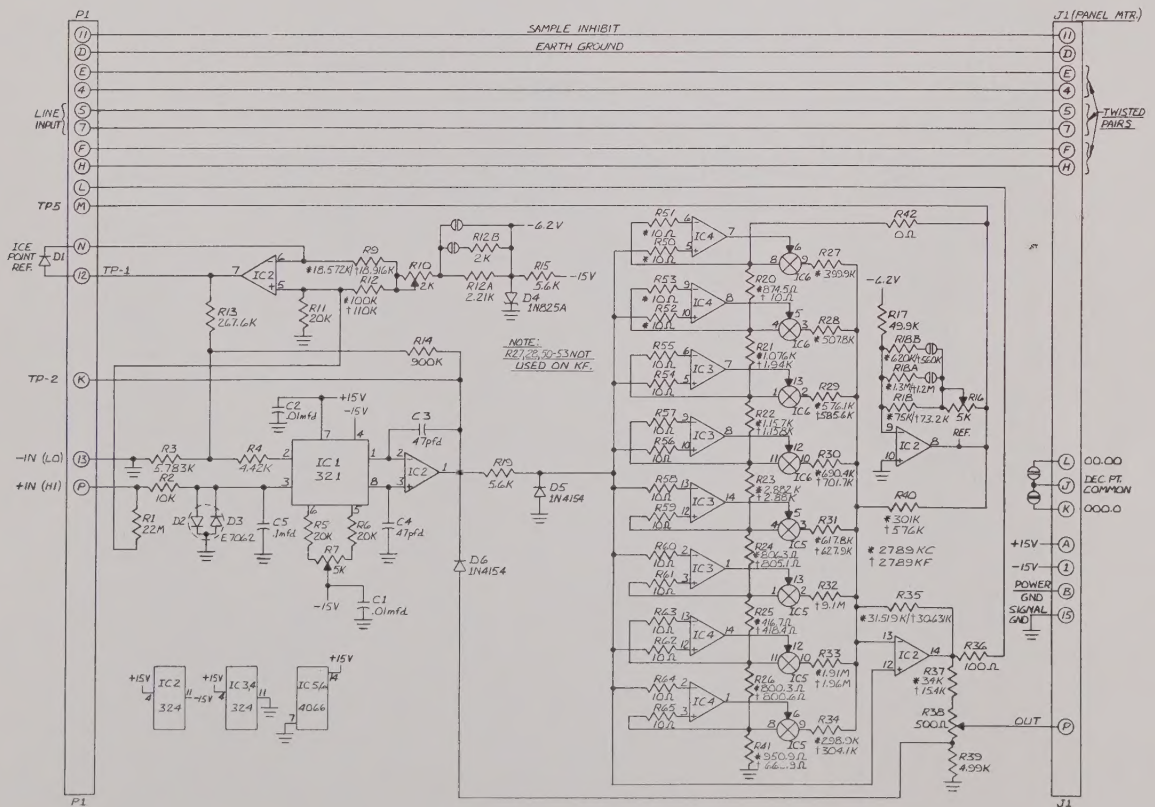
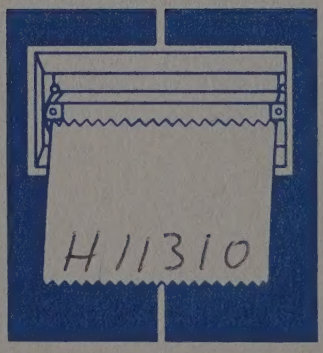
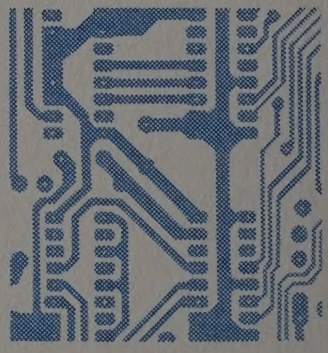


Figure 12
Schematic, Models KC, KF

UNITED SYSTEMS CORP.
918 Woodley Road
Dayton, Ohio 45403
Ph. (513) 254-6251
TWX (810) 459-1728





MP MASTER
MA26225

88-02789JTEK MR102576R6K

Printed in U.S.A.